



Trajectories of general movements from birth to term-equivalent age in infants born <30 weeks' gestation



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ABSTRACT

Background: General movements (GMs) is an assessment with good predictive validity for neurodevelopmental outcomes in preterm infants. However, there is limited information describing the early GMs of very preterm infants, particularly prior to term.

Aims: To describe the early GMs trajectory of very preterm infants (born <30 weeks' gestation) from birth to term-equivalent age, and to assess the influence of known perinatal risk factors on GMs.

Study design: Prospective cohort study.

Subjects: 149 very preterm infants born <30 weeks' gestation.

Outcome measures: GMs were recorded weekly from birth until 32 weeks' postmenstrual age, and then fortnightly until 38 weeks' postmenstrual age. GMs were also assessed at term-equivalent age. Detailed perinatal data were collected.

Results: Of 669 GMs assessed, 551 were preterm and 118 were at term-equivalent age. Prior to term, 15% (n = 82) of GMs were normal and 85% (n = 469) were abnormal, with the proportion of abnormal GMs decreasing with increasing postmenstrual age (p for trend <0.001). By term-equivalent 30% (n = 35) of GMs were normal. On univariable analysis, lower gestational age (p < 0.001), postnatal infection (p < 0.001) and bronchopulmonary dysplasia (p = 0.001) were associated with abnormal GMs. Postnatal infection was the only independent perinatal association with abnormal GMs on multivariable analysis. All four infants with grade III/IV intraventricular haemorrhage (IVH) had persistently abnormal GMs.

Conclusions: GMs were predominantly abnormal in very preterm infants, with a higher proportion of normal GMs at term-equivalent age than prior to term. Abnormal GMs were associated with postnatal infection and IVH.

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1. Introduction

Infants born very preterm are at increased risk for adverse neurodevelopmental outcome, such as motor delay, cognitive impairment and cerebral palsy, compared with their term born peers [1]. Several studies have described the neurodevelopment of very preterm infants when assessed at term-equivalent age (TEA), however there is limited understanding of neurodevelopment prior to term [2–5]. Consequently it is challenging for clinicians to identify, while in the neonatal intensive care unit, those infants who require targeted developmental surveillance and early intervention.

Abbreviations: BPD, bronchopulmonary dysplasia; GMs, general movements; IVH, intraventricular haemorrhage; PMA, postmenstrual age; PVL, periventricular leukomalacia; TEA, term-equivalent age.

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Prechtl's qualitative assessment of general movements (GMs) evaluates an infant's spontaneous movements via observation and can be used from birth until 20 weeks' post-term [6]. Unlike other neurodevelopmental assessments that require handling of the baby, GMs allows clinicians to assess very preterm infants soon after birth, including ventilated infants. Consistently abnormal GMs when observed prior to term, at TEA and at 3–4 months' corrected age, are predictive of adverse neurodevelopmental outcome in preterm infants [7,8]. In particular, the high predictive validity of GMs assessed at three months for later neurodevelopmental outcome is well documented [9–12]. However, there is currently limited information on the trajectory of GMs prior to term, with most studies examining GMs closer to TEA, consisting of small sample sizes, or including only one or two assessments prior to term [13–16]. Furthermore, only a few studies have included very preterm infants and subsequently there is a limited understanding of how GMs may evolve over time for those infants most at risk for adverse neurodevelopment.

Serial GMs assessments provide a more accurate picture of an infant's development than a single assessment [6], as there may be transient changes in the quality of GMs, influenced by perinatal factors, infant behavioural states and clinical interventions, such as postnatal corticosteroids [17–19]. Multiple assessments help to establish the validity of findings and can be used to understand the influence of acute perinatal factors on the infant's early neurodevelopment.

There have only been a few studies of serial GMs in very preterm infants prior to term, particularly in the first few weeks of postnatal life, and these have primarily been small studies [19–24]. In a study of very preterm infants during the first three postnatal weeks, GMs at three weeks, but not earlier, were associated with neurodevelopmental outcome at one year corrected age for 18 infants [21]. Individual GMs trajectories for very preterm infants with perinatal risk factors, such as septicaemia or being born small for gestational age, have also been reported in two of these studies [23,24]. In the largest and most recent study, de Vries and Bos described GMs at four time points across the first ten postnatal days ($n = 45$) and demonstrated that GMs assessed early may help predict neurodevelopmental outcome at two years' corrected age [20]. GMs that became normal over repeated assessments were associated with higher birth weight, lower gestational age and lower Neurobiologic Risk Score [25].

However, there have been no recent studies documenting serial GMs assessments from birth until TEA for very preterm infants in larger cohorts. It is important to establish this trajectory in order to identify what represents normal and abnormal neurodevelopment at various time points prior to term, and to provide a basis of comparison for future studies.

The aim of this study was to describe the early GMs trajectory of infants born <30 weeks from birth to TEA. The study also aimed to explore the relationship between perinatal variables and abnormal GMs. It was hypothesised that abnormal GMs would be associated with known perinatal risk factors for neurodevelopment such as bronchopulmonary dysplasia (BPD), brain injury, male sex, surgery, earlier gestational age or lower birth weight.

2. Methods

2.1. Subjects

This study was part of a larger project investigating neuro-behavioural development from birth to TEA and outcome at two years' corrected age in infants born <30 weeks [26]. Infants were recruited from the Royal Women's Hospital, Melbourne, Australia, between January 2011 and December 2013. Infants were excluded if they had congenital abnormalities known to affect neurodevelopment, non-English speaking parents (as there was no funding for interpreters, and English was a requirement for other assessments as part of the larger study), or a poor chance of survival as assessed by clinical staff. The project had ethics approval from the Human Research Ethics Committees at the Royal Women's Hospital and the Royal Children's Hospital, Melbourne. Infants were usually enrolled in the study towards the end of the first week of life and no more than two weeks after birth, once written parental consent was obtained.

2.2. Procedure for GMs assessments

Serial GMs were videoed weekly from soon after birth until 32 weeks' postmenstrual age (PMA), and then fortnightly at 34, 36 and 38 weeks' PMA. Prior to term, GMs were recorded while infants were inpatients at the Royal Women's Hospital, but not after infants were discharged to another hospital, due to assessor availability, logistical and ethical issues. At TEA, GMs were recorded either as an outpatient at the Royal Children's Hospital, as part of the larger study protocol, or as an inpatient if the infant had not yet been discharged from the Royal Women's Hospital.

GMs were videoed using a standardised procedure. For all assessments, infants were videoed in supine wearing minimal clothing, and the assessor aimed to obtain at least three GMs. Prior to term, infants were videoed with nesting boundaries loosened or removed to allow movement of all limbs. A digital video camera was positioned high above the incubator so that the infant would not visually fixate on the camera, and to allow ready access for clinical staff. Recordings were timed to coincide with nursing care procedures when infants were in an awake behavioural state, with swaddling removed. Infants were videoed for 5–20 min prior to term (depending on the infant's behavioural state, logistical issues and how long it took to observe a minimum of three GMs), and for 5–10 min at TEA.

2.3. General movements scoring

All GMs were scored from the video recordings by assessors who were unaware of the infant's clinical status and neonatal course. Videos from the same infant were scored on separate occasions so that the assessors would not be influenced by the infant's previous scores. All assessors had advanced GMs certification from the GMs Trust.

GMs were assessed using Precht's qualitative assessment of GMs, and classified as normal or abnormal according to their fluency, variability and complexity [27].

Normal GMs have a gradual beginning and end; they involve the whole body in complex and variable patterns of flexion, extension and rotation that give an impression of fluency and elegance. Abnormal GMs were classified as:

- Poor repertoire: repetitive and lacking complexity in force, speed and amplitude, often slower and of shorter duration than normal GMs,
- Cramped synchronised: involving almost simultaneous contraction and subsequent relaxation of all limbs and trunk, characterised by a stop-start quality with minimal or absent rotations, or
- Chaotic: large amplitude movements of all limbs in an abrupt manner, lacking smoothness and fluency.

GMs were considered unscorable if the infant was in a crying behavioural state or hypokinetic. GMs that were considered borderline to score were checked by other members of the research team and consensus was reached. Infants with abnormal GMs received input from the neonatal allied health team according to standard clinical care at the Royal Women's Hospital.

2.4. Reliability

Inter-rater reliability was examined using 80 randomly chosen videos that were scored by two independent raters (JO and AE). Inter-rater agreement was 90%, with a Cohen's kappa of 0.75, indicating good agreement beyond that expected by chance alone. All cases where there were disagreements were reviewed by an experienced third scorer (AS). For intra-rater reliability, 85 GMs were double scored >2 months apart by the same assessor (JO), with 98% agreement between the first and second assessments and a Cohen's kappa of 0.94, indicating excellent agreement beyond that expected by chance alone.

2.5. Perinatal data

Research nurses collected extensive perinatal information from the medical histories and hospital database regarding pregnancy and neonatal course, including gestational age, birth weight, sex, oxygen requirements, postnatal infections, and interventions such as postnatal corticosteroids and surgery.

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